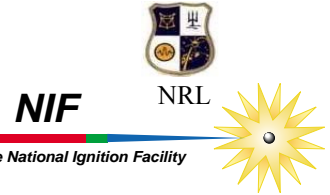


Agenda for the HENEX 65% Design Review



No. of VGs

- | | |
|----|--|
| 8 | 1. Opening (Tina Back, tinaback@llnl.gov) |
| 11 | 2. Design Overview (John Seely, john.seely@nrl.navy.mil) |
| 11 | 3. Mechanical Design (Layne Marlin, lmartin@ssd5.nrl.navy.mil) |
| 10 | 4. Optical Design (Larry Hudson, larry.hudson@nist.gov) |
| 12 | 5. Electronic Design (Rob Atkin, ratkin@tigerinnovations.com) |
| 12 | 6. Interface/Sensor (Glenn Holland, gholland@ssd5.nrl.navy.mil) |
| 9 | 7. Project Schedule (Perry Bell, e061547@popeye.llnl.gov) |

Questions/comments: Please refer to presentation number 2.

73 Total No. of Viewgraphs

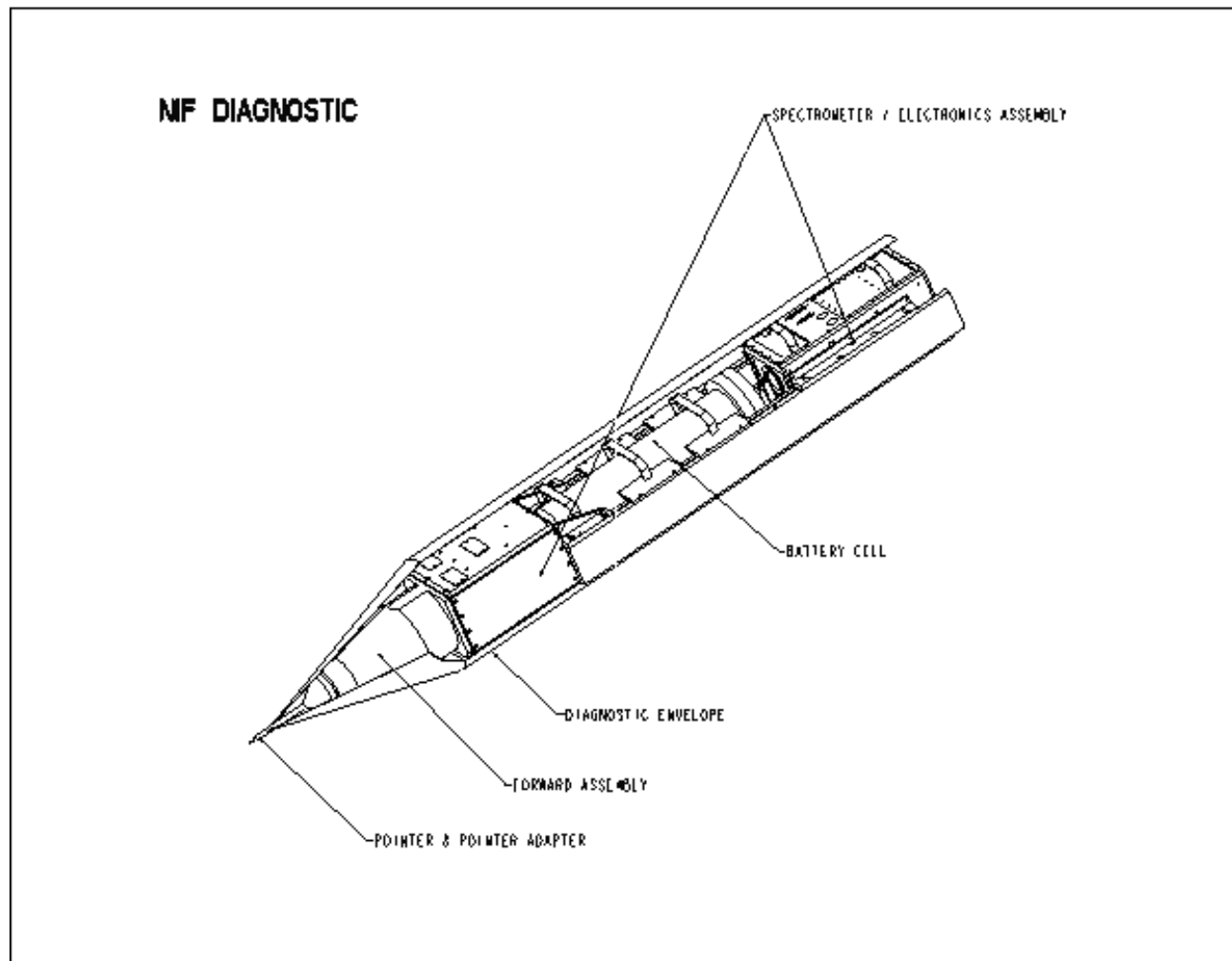
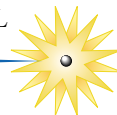
Overview of the HENEX instrument



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SCALE : 0.167 TYPE : ASSEM REP : Master Rep
NAME : HIFF SIZE : E

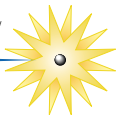
Description of compact and portable HENEX instrument



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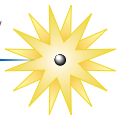
- **HENEX is designed to operate in the NIF DIM and the LLE TIM.**
- **The x-ray dispersive elements are five crystals used in reflection or transmission.**
- **The standoff distance from the target is changeable (0.5 m or 2.2 m).**
- **Two SMA 62.5 micron fibers handle triggering and data transmission.**
- **The baseline electronic detectors are 12 bit resolution and controlled by low-power custom built readout/drive electronics housed inside the Drive Electronics (DE) package in the rear of the instrument.**
- **The instrument is designed so that no data are retained when the power is disconnected.**

Prototype Hard X-ray Spectrometer (HXS) was deployed at the Omega laser in Nov. 2000

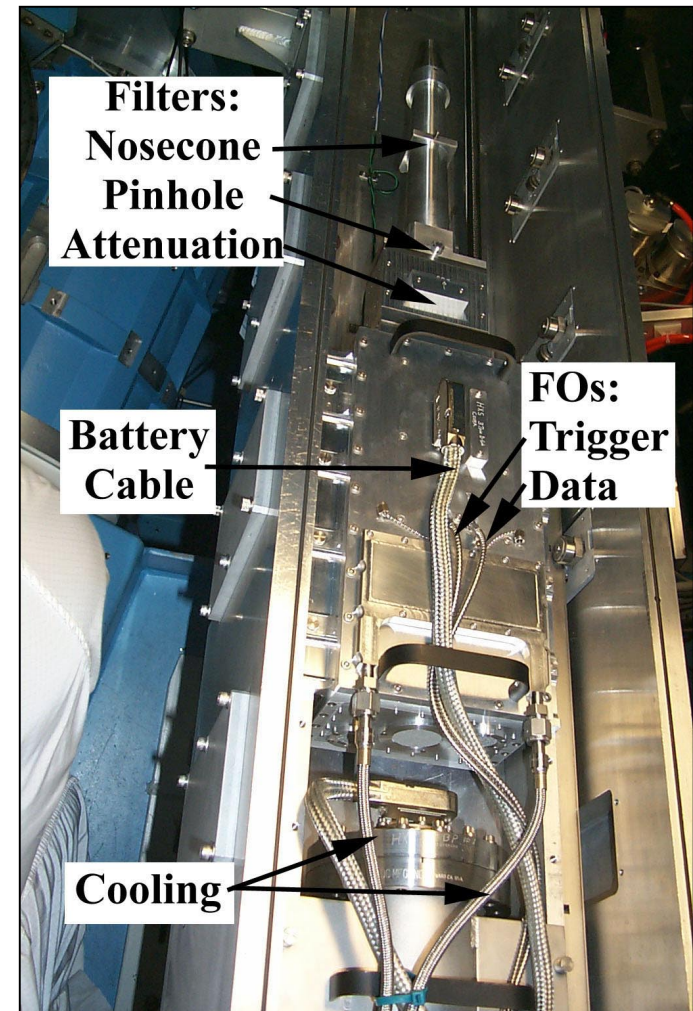


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- **Prototype HENEX components:**
 - Transmission crystal (covering 12 - 60 keV).
 - Electronic detection (CCD).
 - On-board computer and drive electronics.
 - Powered by an internal battery pack.
 - Command/control and data transmission via fiber optic links from the instrument to a remote computer/interface unit that is connected to the host facility network.



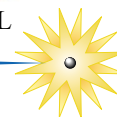
Example of raw HXS data



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Filters:

Open

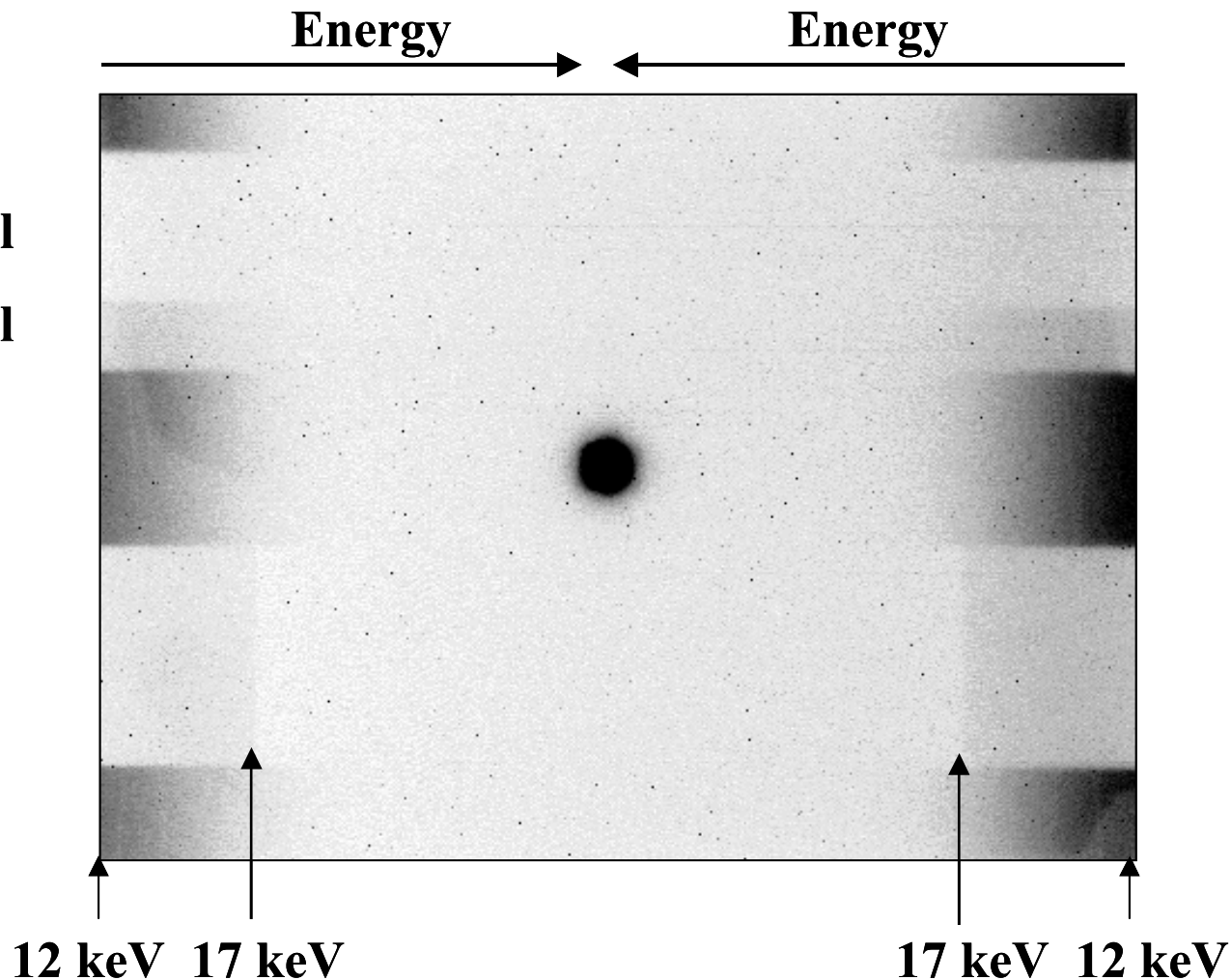
Cadmium 2 mil

Cadmium 1 mil

Open

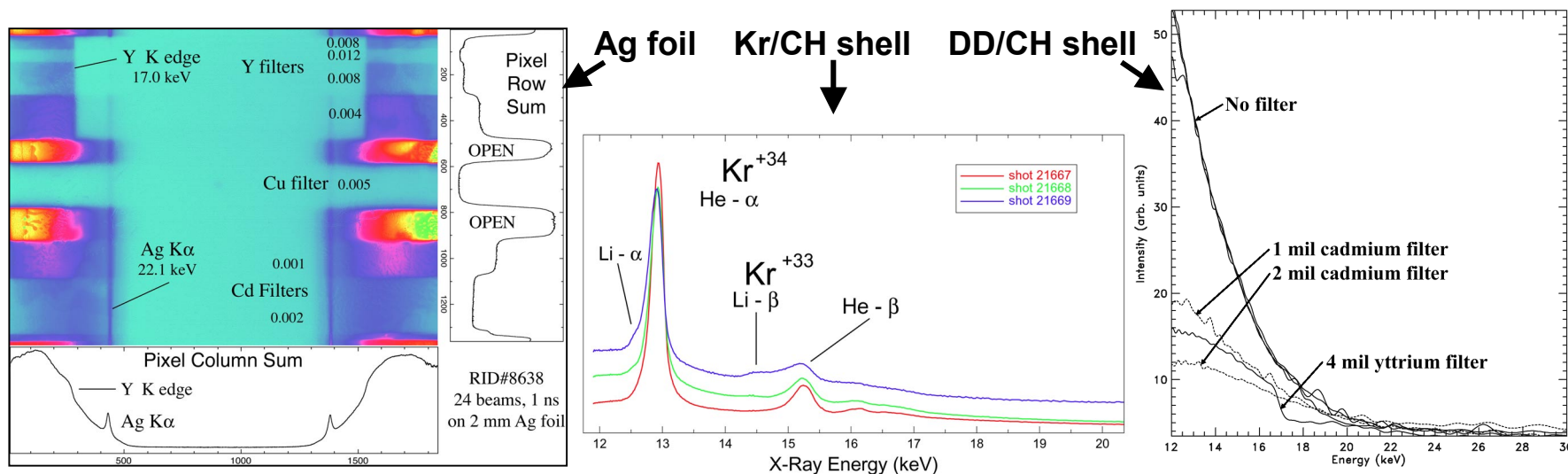
Yttrium 4 mil

Open



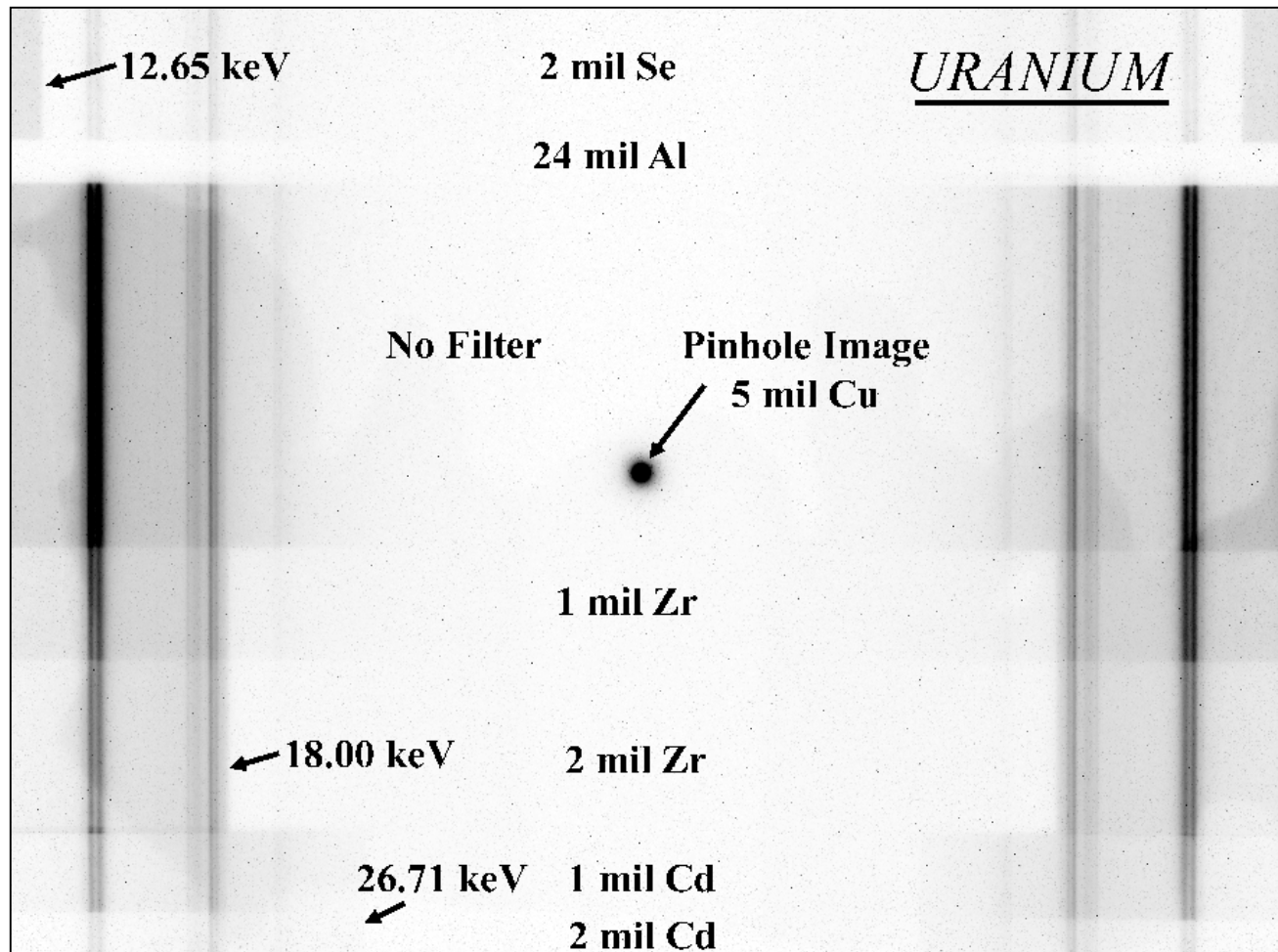
Hard X-Ray Spectrometer (HXS) results

- Technical issues were resolved during 11/13-17/00:
 - Upgraded the TIM#2 FO vacuum feedthrough and umbilical cabling.
 - Added 1/2" lead shielding to the Drive Electronics box.
- Spectral images were successfully recorded on all 11 shots on 11/21/00:
 - Two gold foils and one silver foil.
 - Five gold spheres (dedicated to the French DMX instrument).
 - Three krypton-filled CH shell targets.
- Spectra from Pb and U targets were recorded on 1/21/01.
- All HXS field test results are on the website spectroscopy.nrl.navy.mil.



Uranium and Lead Spectra were Recorded

Inner-shell transitions from nickel-like and nearby ionization stages

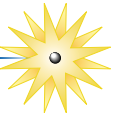


65% Design Review Requirements



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- (1) **Addressing comments of concern documented at the CDR review (John Seely)**
- (2) **Demonstration that the design meets performance specifications (Larry Hudson)**
- (3) **A block diagram including all sub-sections of the diagnostic (Layne Marlin)**
- (4) **Completion of CAD design models (Layne Marlin)**
- (5) **Identification of the number of detail drawings needed to complete the diagnostic (Layne Marlin)**
- (6) **Completion of product data sheets under configuration control (Glenn Holland)**
- (7) **Identification of suppliers of major components (Glenn Holland)**
- (8) **Cost estimates from vendors for vendor-built equipment (Glenn Holland)**
- (9) **Identification of acceptance test requirements (John Seely)**
- (10) **Identification of calculation requirements (electrical circuit evaluation, structural response, shielding, etc.) (Glenn Holland)**
- (11) **Identification of all control points and monitoring functions (Rob Atkin)**
- (12) **Identification of interface requirements (Glenn Holland)**
- (13) **Demonstration of conformation to NIF diagnostic-relevant guidelines (Glenn Holland)**
- (14) **Estimated operation and maintenance costs and schedules (Glenn Holland)**
- (15) **A discussion of failure modes (John Seely)**
- (16) **A description of the control, data retrieval and triggering systems (Rob Atkin)**

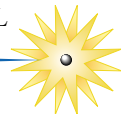
Addressing comments of concern documented at the CDR review



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Document on the website spectroscopy.nrl.navy.mil has detailed responses to all CDR questions:

Responses to the HENEX CDR Comments/Questions

The CDR Comments/Questions were emailed to NRL on January 19, 2001. A response is provided after each comment/question.

Comment/Question Impact Types:

1=If left unresolved, could result in a recommendation of "rejection of a specific aspect of design."

2=If left unresolved, could result in a recommendation of "acceptance of the design with comment."

3=Comments that provide information and suggestions to the design team.

Pages refer to the CDR presentation at the website

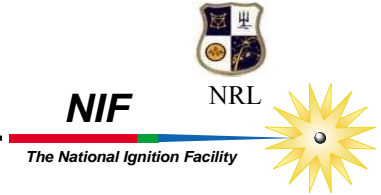
http://spectroscopy.nrl.navy.mil/HENEX/Reviews/CDR_viewgraphs.pdf

A. Brian MacGowan

A.1. (Type 1, Pages 20/21) The issue of triggering of the CCD readout of the HENEX was discussed. The engineers working on the HENEX were designing their system so that at t-10 sec you were committed to acquiring data between t-0.5 and t+0.5 sec. I believe that this is consistent with the way Omega operates. This may not be consistent with the way NIF will be controlled as the shot approaches. There may be holds that would upset this plan. All of that needs to be looked into and that comment was mentioned at the review. However, afterwards, I realized that this is a generic problem for multiple diagnostics and that we shouldn't be spending money designing a unique solution to this problem for HENEX or any other diagnostic. The diagnostics group should have a generic solution to synchronizing CCDs to the NIF shot sequence. That solution (possibly with a simple modification to make it compatible with Omega) should be provided to the HENEX designers.

Perry Bell: I have followed up on this issue with the integrated command and controls group. They have up-dated their plans and have established the sequencing of the shot cycle. It basically boils down to software to hardware handoff a t-2 sec. Diagnostic builders can not start any process that requires better than 15 sec resolution during the software controls phase. After the software to hardware handoff, the system is accurate to 30 ps rms.

Identification of acceptance test requirements



Document on the website spectroscopy.nrl.navy.mil describes the acceptance test plan:

HENEX Acceptance Test Plan

Contents:

HENEX Components

Operating Modes

Off-Line Tests

Deployment in the Instrument Insertion Module (TIM and DIM)

Instrument Start-Up

Discussion of failure modes

Document on the website spectroscopy.nrl.navy.mil has failure mode analysis:

Priority levels: 1=High, 2=Moderate, 3=Low. Probability in %.

Component	Priority	Probability	Event	Effect	Management	Comment
Nosecone	3	20	Misalignment of the pointer or the DIM to the source position.	Shift of the spectra on the sensors.	Implement attenuation filters and compute new energy scale using absorption edge positions.	Analytic expressions for the energy scales have been derived.
Nosecone	2	20	Entrance filter bursts.	Additional x-ray flux and visible light reach the sensor. Filter must be replaced.	The filter supports are designed for easy filter replacement.	Most likely for the thin filter on the lowest energy channel.
Spectrometer	3	10	Crystal breaks.	Crystal must be replaced.	Spectrometer is detached from the instrument, disassembled, and the new crystal and mount are inserted.	The crystal thickness is chosen to accommodate the bending radius.
Sensor	3	10	Sensor filter bursts.	Additional x-ray flux and visible light reach the sensor. Filter must be replaced.	Sensor/filter module is designed to be easily withdrawn, and the filter is replaced.	Unlikely because the sensor's filter is protected by the crystal and the entrance filter.
Sensor	3	10	Sensor fails because of EMI.	Destruction of the sensor.	EMI shielding is implemented. Sensor module is easily withdrawn, and the sensor can be replaced.	EMI shielding was successful for HXS.
Battery	1	<<1	Battery pressure vessel fails.	Dispersal of contaminants into the target chamber.	Engineering analysis indicates the battery pressure vessel is structurally over designed by at least a factor of 100.	Tiny probability, huge consequences.
Electronics	3	10	Electronics fails because of EMI.	Destruction of the electronics.	EMI shielding is implemented.	EMI shielding was successful for HXS.
Cables	2	30	Trigger failure because of signal loss in the fiber optics.	No data are recorded.	Trigger and data links are verified prior to the shot.	Trigger failure occurred during HXS operations.